Fabrication Process Development for Light Deformable Mirrors

Completed Technology Project (2011 - 2013)

Project Introduction

The project objective is to develop robust, reproductibble fabrication processes to realize functional deformable membrane mirrors (DM) for a space mission in which multiple nanosatellites will demonstrate in-orbit self-assumbly of a space telescope. These mirrors are made of thin layers of a piezoelectric polymer (PVDF), patterned in unique ways to provide surface-parallel actuation. Each wafer-scale mirror contains on the order of 100 dependent actuating elements.

This development is a collaborative effort between California Institute of Technology (Caltech) and the Jet Propulsion Laboratory (JPL). The fabrication is done using complementary facilities at the Kavli Nanoscience Institute (KNI) of Caltech, and the Microdevices Laboratory (MDL) at JPL. There are two parallel processes being developed. One involves the deformable mirror it self. The other involves process development of ultra-low thermal exopansion bi-metallic reflective layer that provides thermal stability to the mirrors using a mechanical grid. The mirror fabrication process involves forming micron-thick layers of PVDF with the required electrode patterns. Two approaches are being developed. Both approaches begin by depositing stack of piezoelectric films and electrodes over a Silicon wafer substrate. In the first approach, the silicon wafer is removed by plasma-based reactive ion etching (RIE)followed by a non-plasma dry etching with Xenon Difluoride (XeF2). In the second approach, the actuator film stack is immersed in a liquid such as deionized water. The adhesion between the actuator film stack and the substrate is relatively weak. Simply by seeping liquid, the actuator film stack is gently released from the substrate. The bi-metallic mesh structure fabrication is being pursued using deposition of dissimilar metals in lithographed patterns followed by sacrificial release processes. This process is now being transferred to a more robust approach that employs Silicon-on-Insulator (SOI) based fabrication processes. A stack that is produced when both of the above-mentioned structures are integrated will be a deformable mirror that is expected to have high tolerance against suface errors from temperature variations while in space.

Anticipated Benefits

N/A

Project Image Fabrication Process Development for Light Deformable Mirrors

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Innovation Fund: JPL CIF

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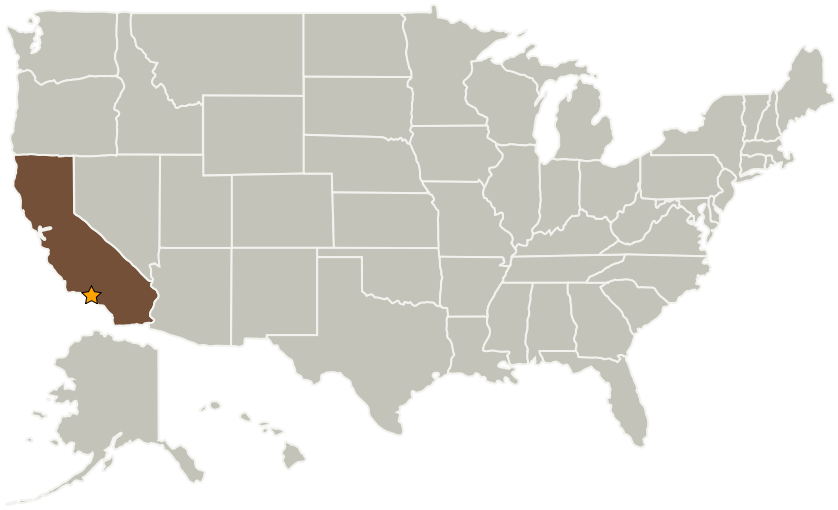
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Management

Program Director:
Michael R Lapointe

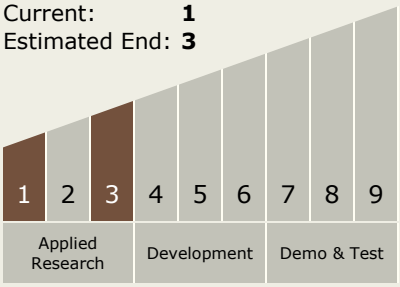
Program Manager:
Fred Y Hadaegh

Project Manager:
Jonas Zmuidzinas

Principal Investigator:
Harish M Manohara

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.1 Mirror Systems

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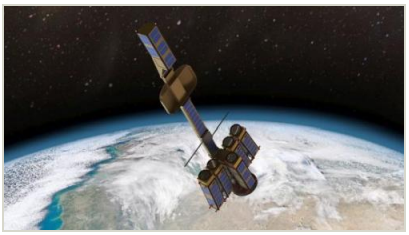
Images



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Project Image Fabrication Process Development for Light Deformable Mirrors
(https://techport.nasa.gov/image/1161)